



human energy®

2019 European Robotics Forum Inspection and Maintenance Robotics Workshop **Advanced Inspection using Robotics Systems**

Mauricio Calva; Chevron ETC; NDE & Inspection SR/TD Program Manager
Peter Tran; Chevron ETC; NDE and Inspection
Russell Brown; Chevron ETC; Reliability

Opportunity: Safety, Quality and Cost

- **Safety on Inspection and Maintenance Activities.**

- Elevated and remote structures
- High temperatures
- Unsafe atmospheres
- Underwater operations

- **Inspection data quality.**

- Improve sensitivity, sizing accuracy & coverage. Better data better decisions
- Inspection through barriers: marine growth, insulation, concrete, corrosion barriers

- **Cost of inspection and impact on operations.**

- Understand what we currently do and how to use new technologies to have an economic impact.



Strategies:

- Non-Intrusive external inspection (NII) – In Service
- Remote- No Entry in Confined Spaces – In T/A
- Permanent Monitoring. Point and extended coverage



Robotic Systems for Inspection, our Vision



Risk:

- Avoid Confined Space Entries
- Avoid Elevated work
- Reduce the time of execution
- Remote operations

Cost:

- Reduce the time of inspection including scaffold erection, confined space entry permits.
- Avoid extensive equipment preparation and cleaning for inspection

Quality:

- Reduced Human Factors
- Images, video and data for further review.
- Better reach and coverage



Chevron areas of development for robotic systems

- In-Service Tank Floor Inspection.
 - Evaluate the floor of tanks while in service, avoiding confined space entries, increasing quality data and the period for internal inspection.
- Pressure and Storage Vessels during turnarounds.
 - Avoid confined space entries and associated activities like internal scaffold. Increase quality of data and maintaining full records of vessel interior, reduce the overall time and cost of inspection.
- Piping Systems.
 - Avoid access to dangerous locations, increase data quality, reduce the overall cost of inspections.
- Ground Operator Robotics
 - Remove personnel from remote and dangerous locations, presence on unmanned installations, emergency response activities.

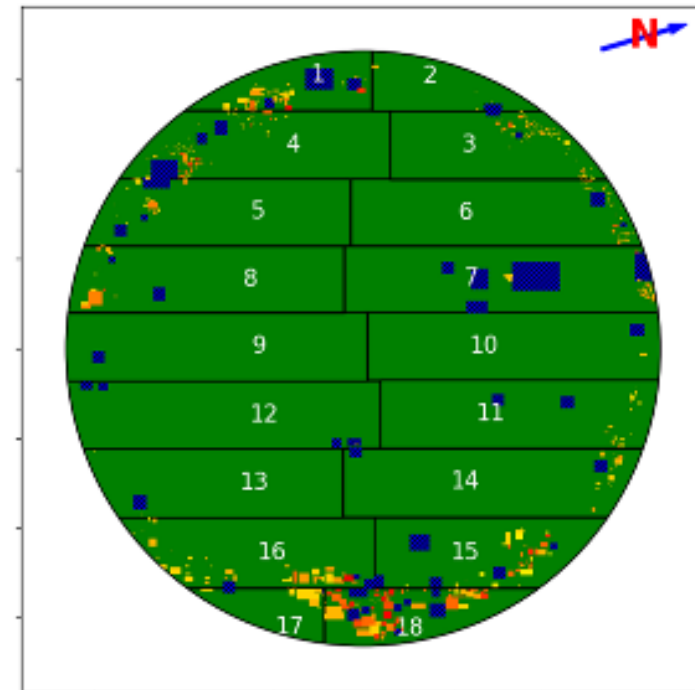


1. Tank Floor Inspection System

Diakont STINGRAY Online Tank Floor Inspection System:

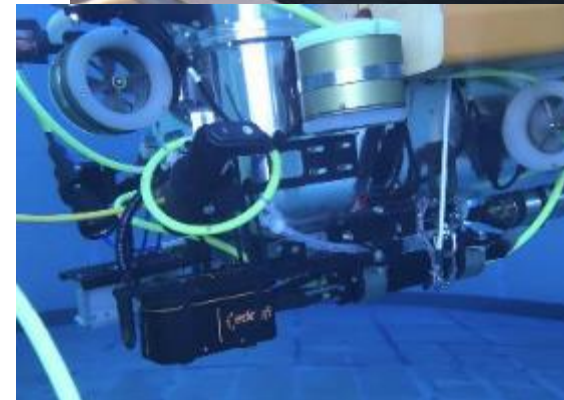
- API 653 tank floor inspection service for filled tanks
- Class 1 Div. 1 system
- Complete NDE coverage, including annular ring critical area
- Motorized brush, plow, and jets for sludge displacement
- Real-time automated tank floor mapping
- 3D imaging sonars for obstacle avoidance
- Entire system bonded, for anti-static and voltage equalization
- Fail-safe redundancy and emergency retrieval features

Utilizes a combination of MFL for detection, and a 96-element UT array for sizing



2. Autonomous System for Tank Inspections

- Mini-ROV based system.
- Ultrasonic and Pulsed Eddy Current sensor
- Full coverage
- Tetherless
- Fully autonomous. Will recognize the environment, map the obstructions and create a pattern to scan the tank floor without human intervention.
- Continuing developing the NDE package
- Going for Class 1 Division 1 Certification, system will be available in 2020.



3. Robotics for Internal Inspection

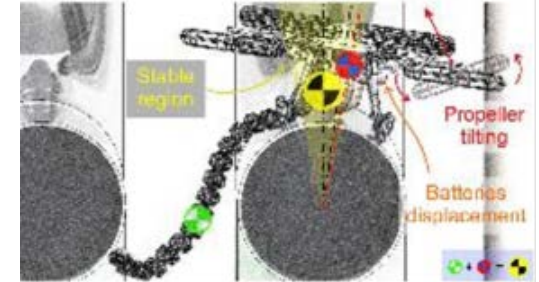
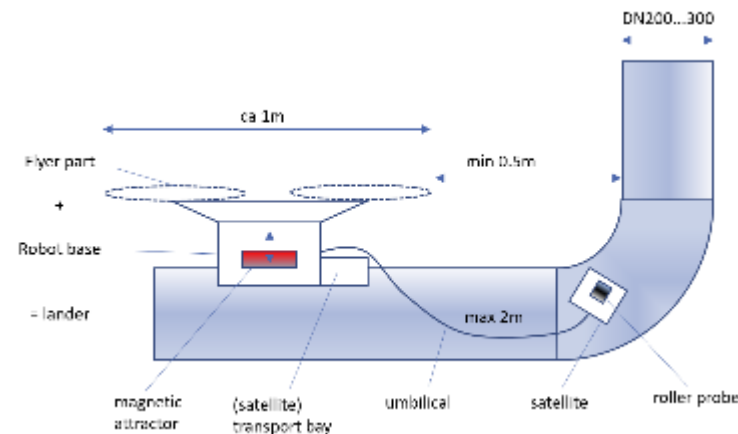
- Magnetic wheeled based systems for internal inspection of pressure vessels.
- Magnetic wheeled based platforms with high resolution and zoom/pan/tilt, ultrasonic point thickness, structured light system for corrosion characterization.
- Crash tolerant aerial system with high resolution camera.
- Multiple platforms are now available in the market.
- Used to avoid confined space entries during turnaround and shutdowns.
- Provide high quality data, images and videos for a complete API evaluation.
- For Pressure and storage vessels, reactors, storage tanks, etc.



4. Piping Systems

Piping thickness measurements at height:

- Traditional Method
 - Scaffold access
 - Rope access
 - Labor intensive
- Hyfliers Project
 - Research project – 100% funded by European Union H2020 program
 - Developing experimental prototypes
 - Fly and land on pipework at height
 - Crawl along pipe and take thickness measurements
 - Completion date Q4 2021



5. Ground Robot for Un-Manned Facilities and Emergency Response Systems

Use for unmanned facilities and emergency response:

- Crawler robots, able to climb stairs
- Teleoperated and autonomous modes
- Carry a range of sensors on board
 - Gas detection
 - Methane, Hydrogen Sulphide, Sulphur Dioxide, Oxygen
 - HD video
 - Infrared camera
- Manipulation arm
- Class 1 division 1 and / or ATEX zone 1 certified for use in hazardous areas



Future work

- Demonstrate, test and deploy available systems in our facilities.
- Promote the adoption of these solutions as normal inspection procedures.
- Support further development and increased capabilities of available systems.
- Engage with groups like Eurobotics, Sprint Robotics, IEEE and others to promote and stimulate this market.

